

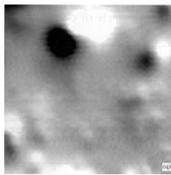
Magnetic Domain Structure of the Magnetic Semiconductor $Ga_{1-x}Mn_xAs$

U. Welp and V. K. Vlasko-Vlasov

Motivation

- $Ga_{1-x}Mn_xAs$ is a magnetic semiconductor with great potential for integration into spintronics applications.
- Magnetic structure of in-plane magnetized films is expected to form the basis for most applications, but remains largely unknown.

300 μm



Scanning SQUID image of In-plane magnetized irregular domains in $Ga_{1-x}Mn_xAs/GaAs$

T. Fukumura *et al.*, Physica E 10, 135 (2001).

Spintronics

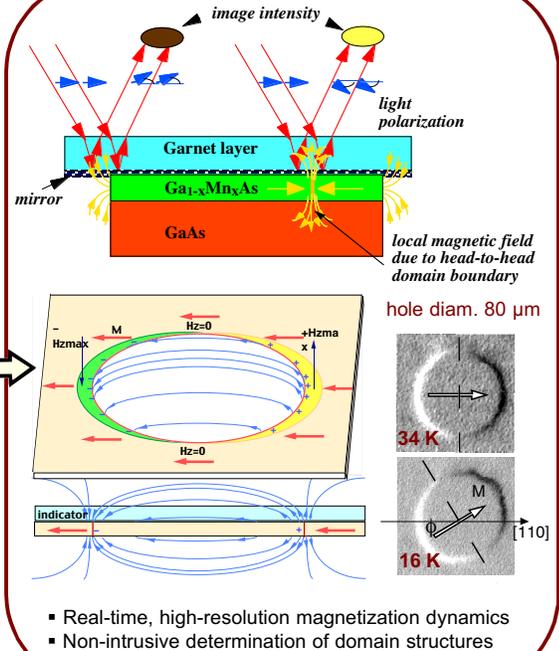
Electron spin for carrying and processing of signals and information



X. Liu, J. K. Furdyna, T. Wojtowicz



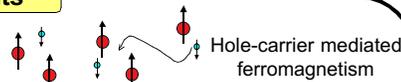
Tool: Magneto-optical Imaging



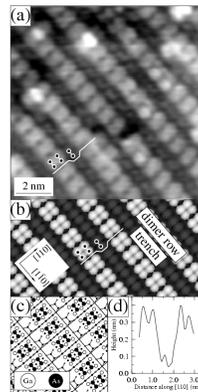
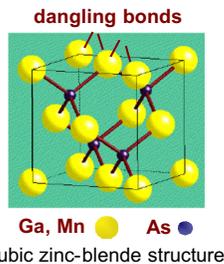
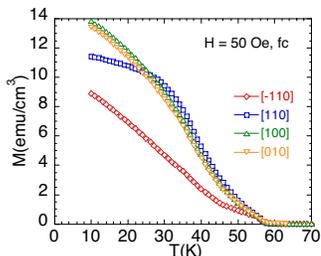
Results

Magnetic Structure

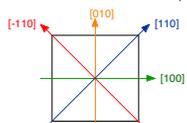
- Large, well formed domains observed
- Transition from biaxial to uniaxial anisotropy



Magnetic Anisotropy

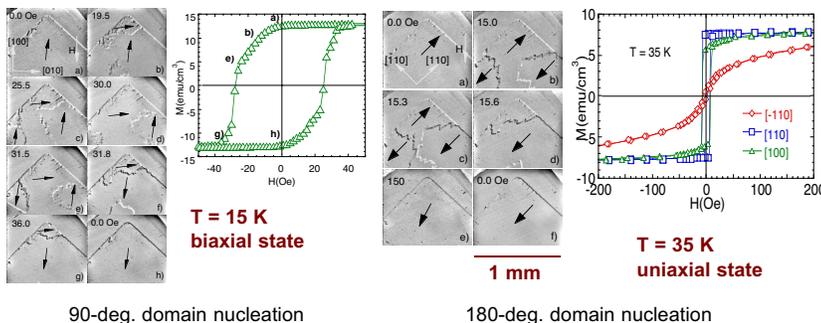


STM: V. P. LaBella *et al.*, PRL 83, 2989 (1999).



Switching Mechanism

Domain images during magnetization reversal in biaxial and uniaxial state. Black arrows show the moment orientations.



Tool: SQUID Magnetometry

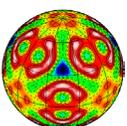
Impact

- Establishment and control of magnetic structures prerequisite for applications
- Attest to wide variety of magnetic structures that can be engineered in $Ga_{1-x}Mn_xAs$

Future directions

- Control of magnetic state by
 - Light
 - Electric fields
 - Strain (epitaxial, tensile, compressive)
- Applications
 - Spin injectors
 - Magnetic tunnel junctions
 - Sensors
 - Giant planar Hall effect devices

U. Welp, V. K. Vlasko-Vlasov, X. Liu, J. K. Furdyna, and T. Wojtowicz, Phys. Rev. Lett. 90, 167206 (2003).



BES - DOE

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MSD - ANL

